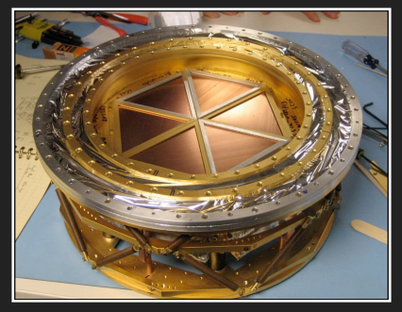
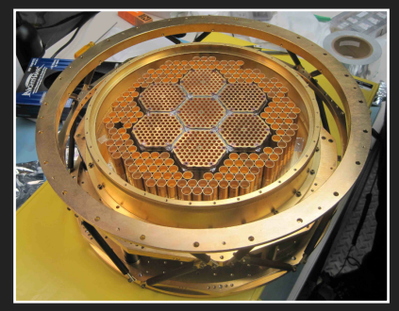
EXPLORING THE COSMOS FROM THE BOTTOM OF THE EARTH

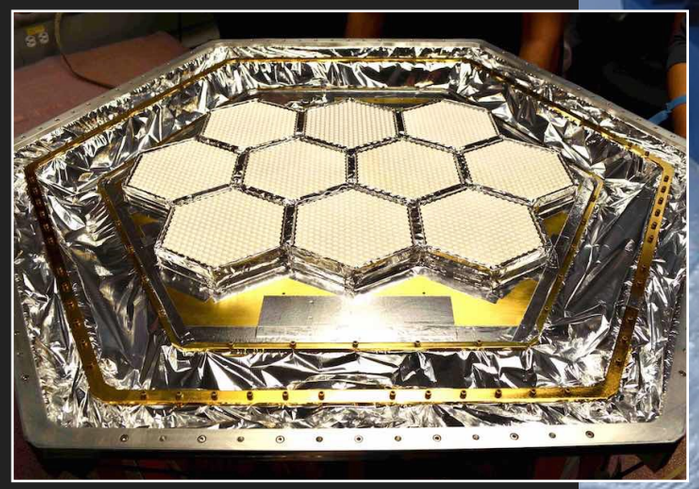
SASHA RAHLIN

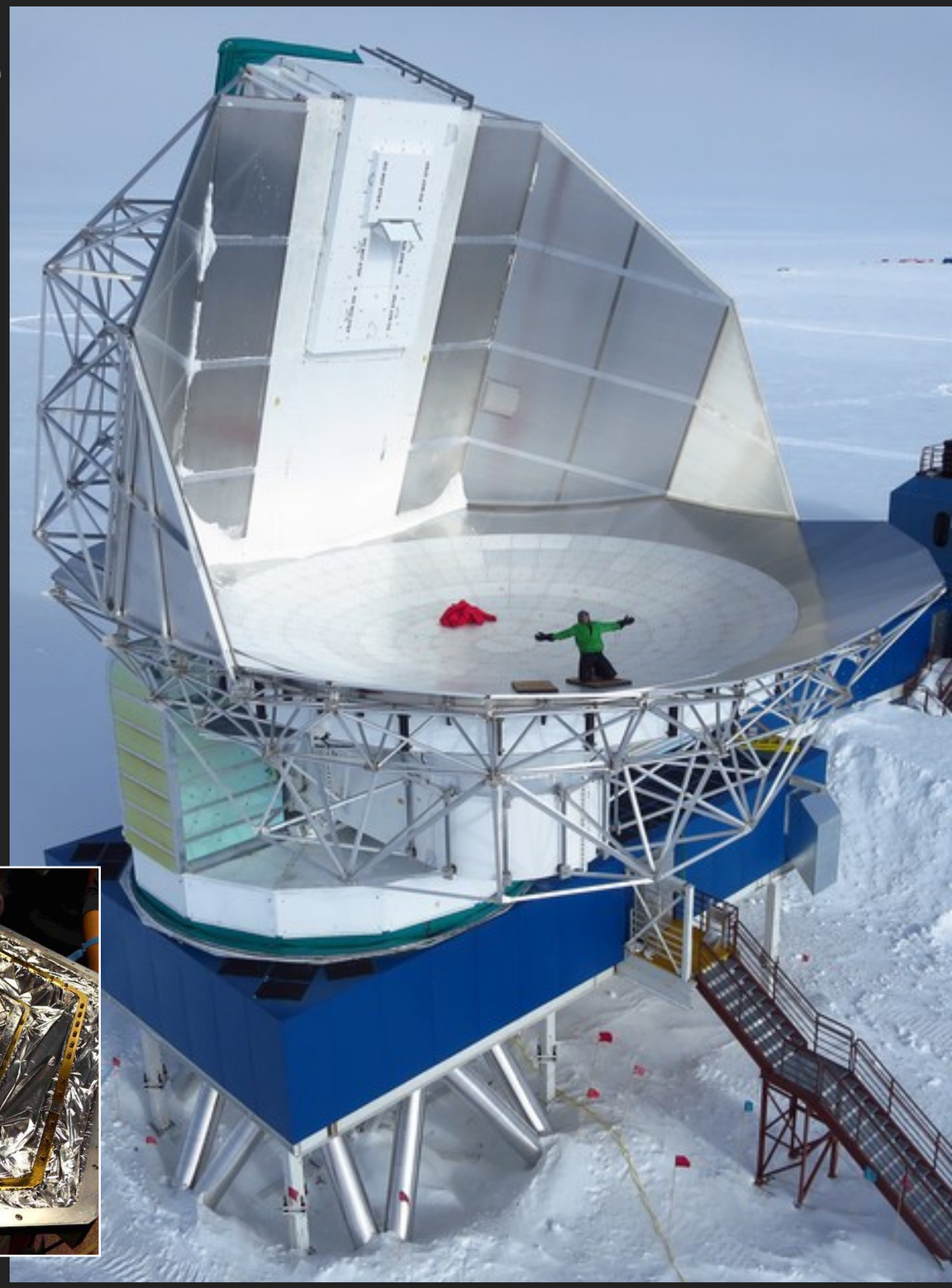
THE SOUTH POLE TELESCOPE

- 10-m sub-mm quality wavelength telescope
  - 100, 150, 220 GHz
  - 1.6, 1.2, 1.0 arcmin resolution
- 2007: SPT-SZ
  - 960 detectors
  - 100, 150, 220 GHz
- 2012: SPTpol
  - 1600 detectors
  - 100, 150 GHz
  - +polarization
- 2017: SPT-3G
  - ~16,200 detectors
  - 100, 150, 220 GHz
  - +polarization









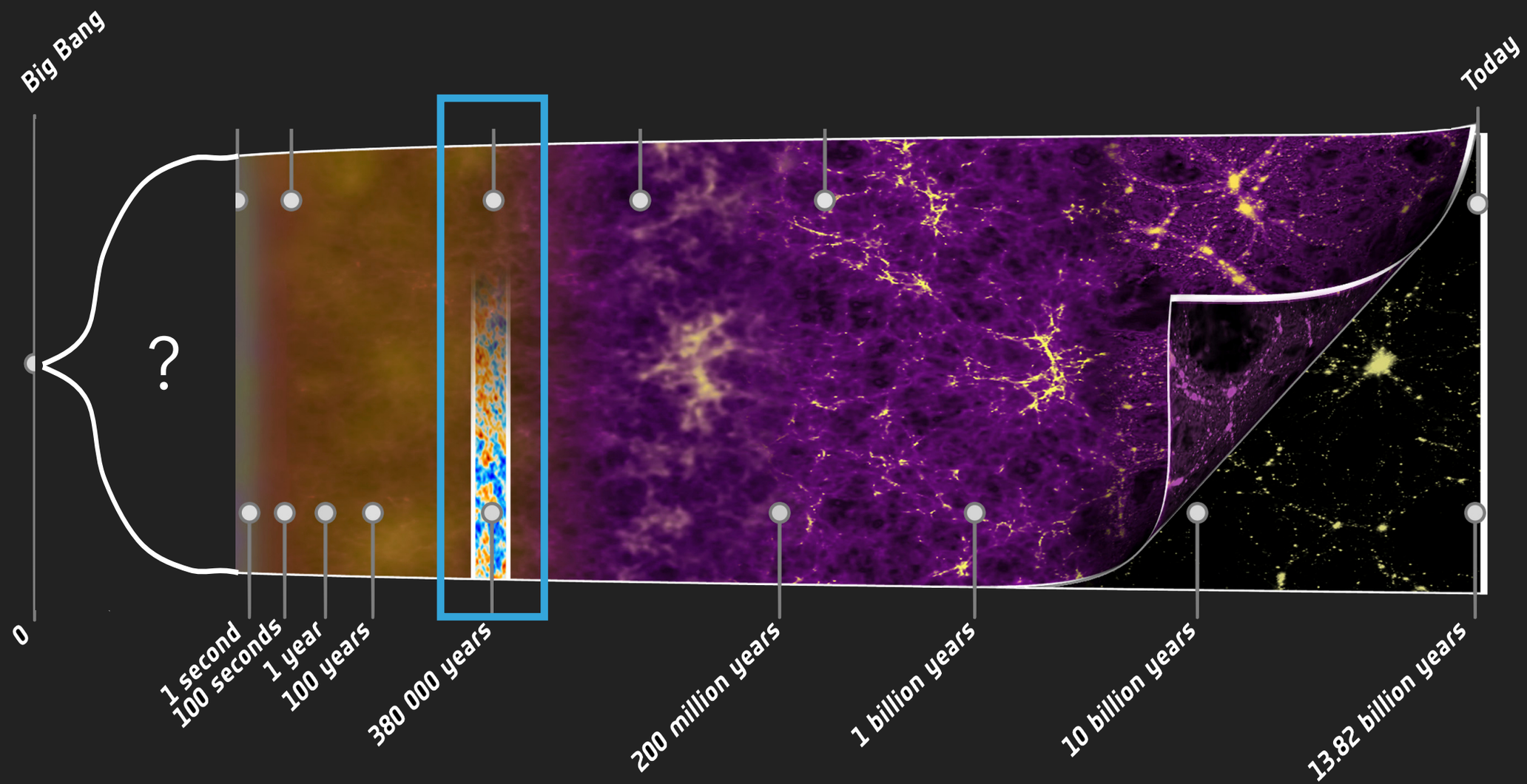
THE SOUTH POLE IS THE BEST PLACE IN THE WORLD TO OBSERVE MICROWAVE EMISSION

- High Altitude (~10,000 ft)
- Extremely Dry
- Stable Atmosphere
- Transparent to microwaves

WHAT'S THE OLDEST THING WE CAN SEE?

THE HISTORY OF THE UNIVERSE

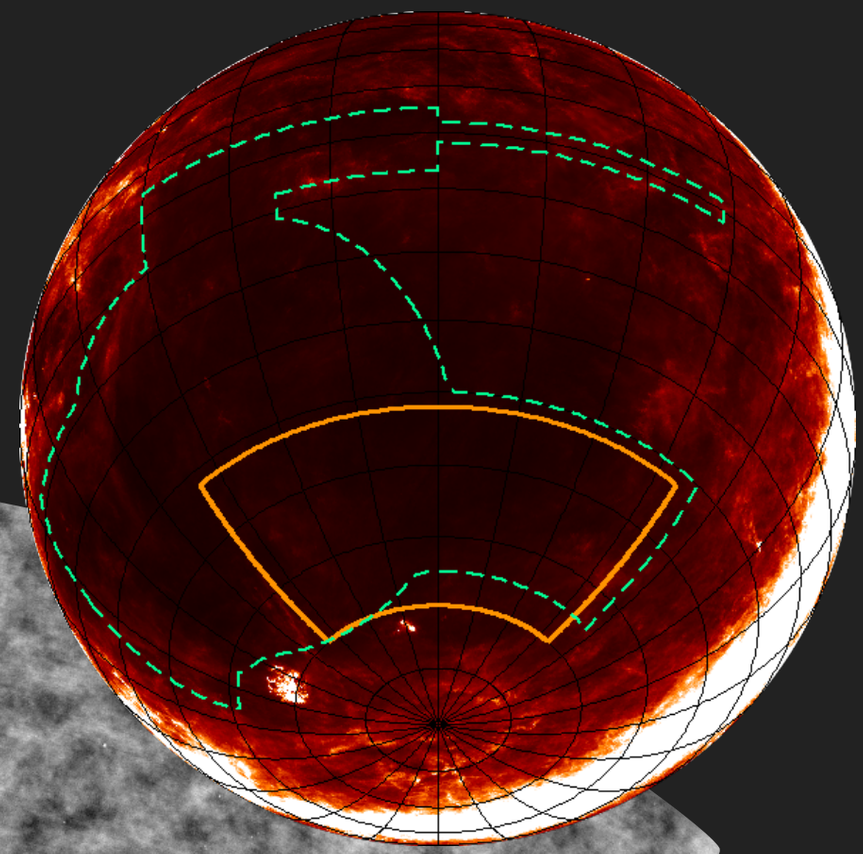
Decoupling of photons from matter: Cosmic Microwave Background (CMB)

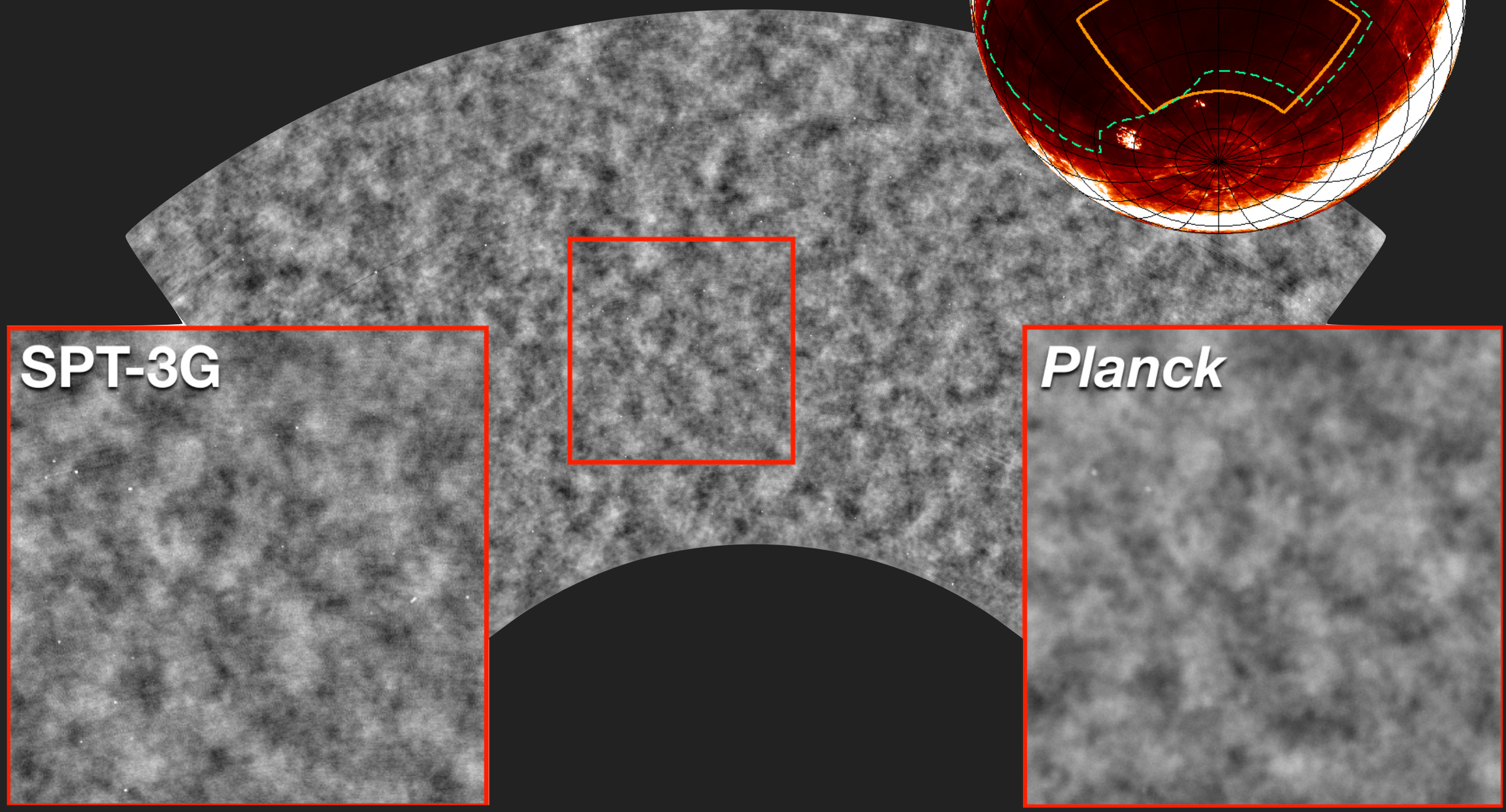


http://sci.esa.int/planck/

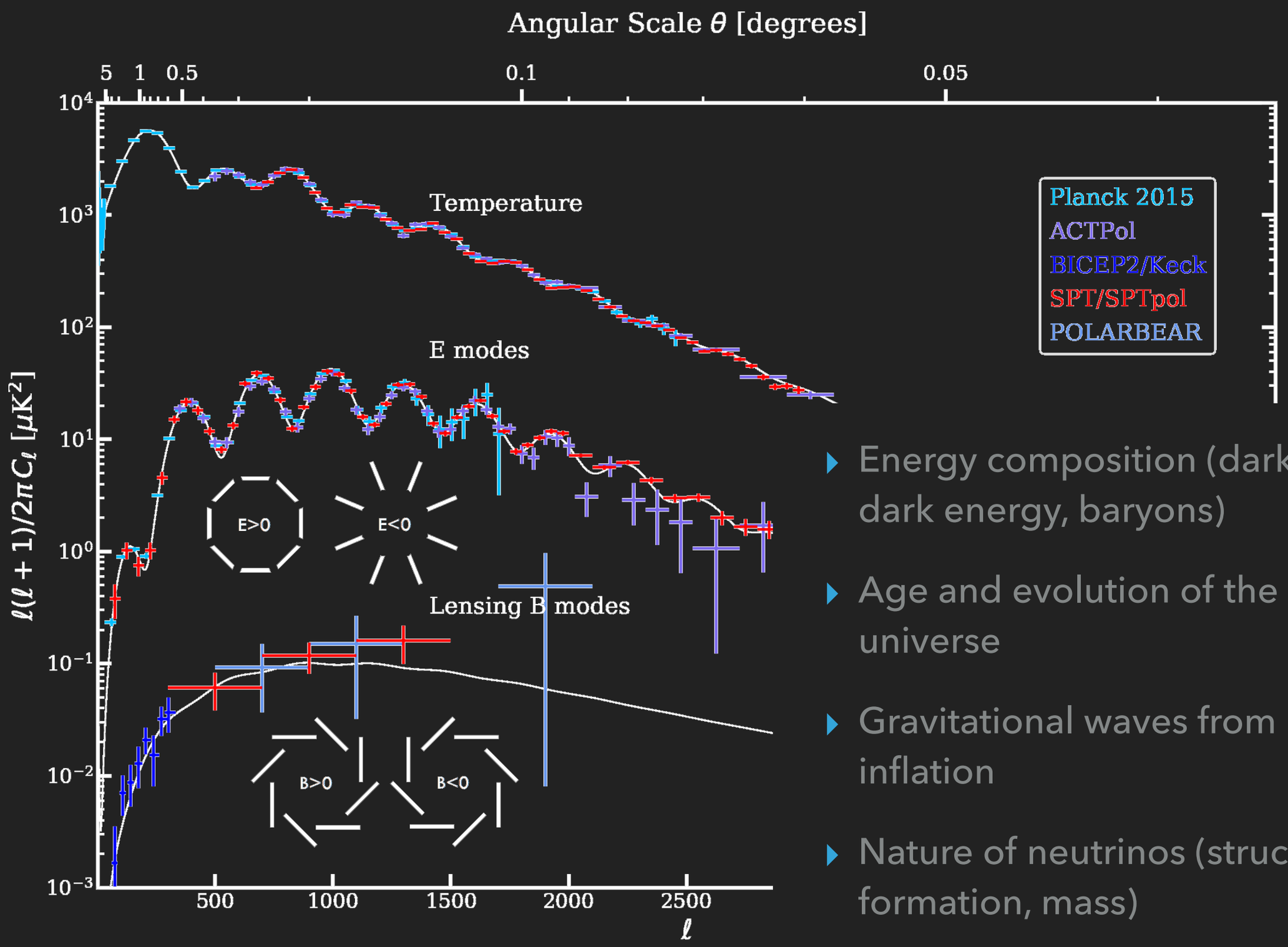
SPT–3G SURVEY

- 1500 sq deg





ANGULAR POWER SPECTRUM



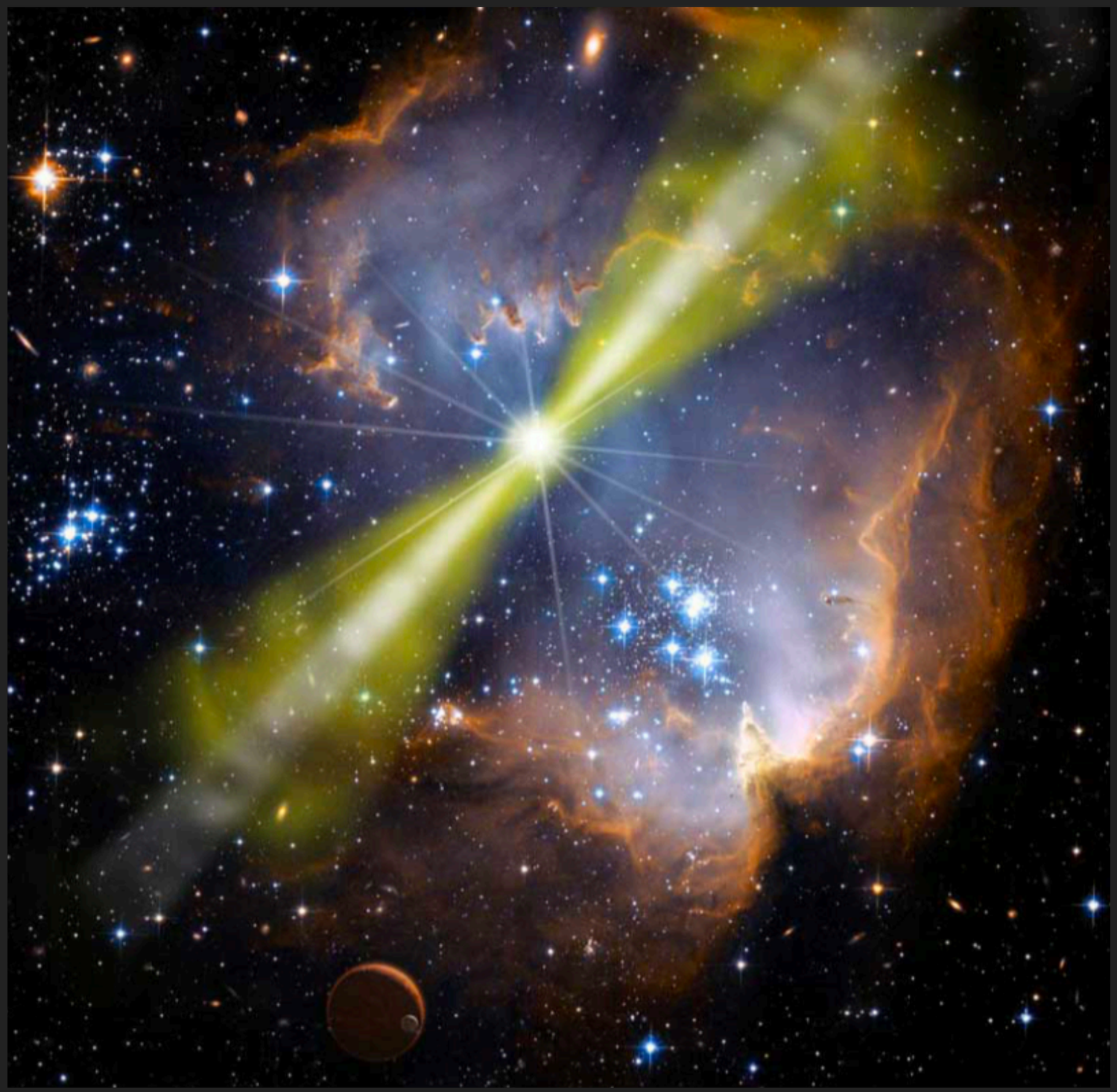
- Energy composition (dark matter, dark energy, baryons)
- Age and evolution of the universe
- Gravitational waves from inflation
- Nature of neutrinos (structure formation, mass)

ApJ 852:97, 2018

WHAT'S THE WEIRDEST THING WE CAN SEE?

GAMMA RAY BURSTS

- Oldest, brightest, furthest objects in the universe



NASA/Swift

ACCIDENTAL DISCOVERY BY VELA SATELLITES

THE ASTROPHYSICAL JOURNAL, 182:L85–L88, 1973 June 1
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OBSERVATIONS OF GAMMA-RAY BURSTS OF COSMIC ORIGIN

RAY W. KLEBESADEL, IAN B. STRONG, AND ROY A. OLSON

University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico
Received 1973 March 16; revised 1973 April 2

ABSTRACT

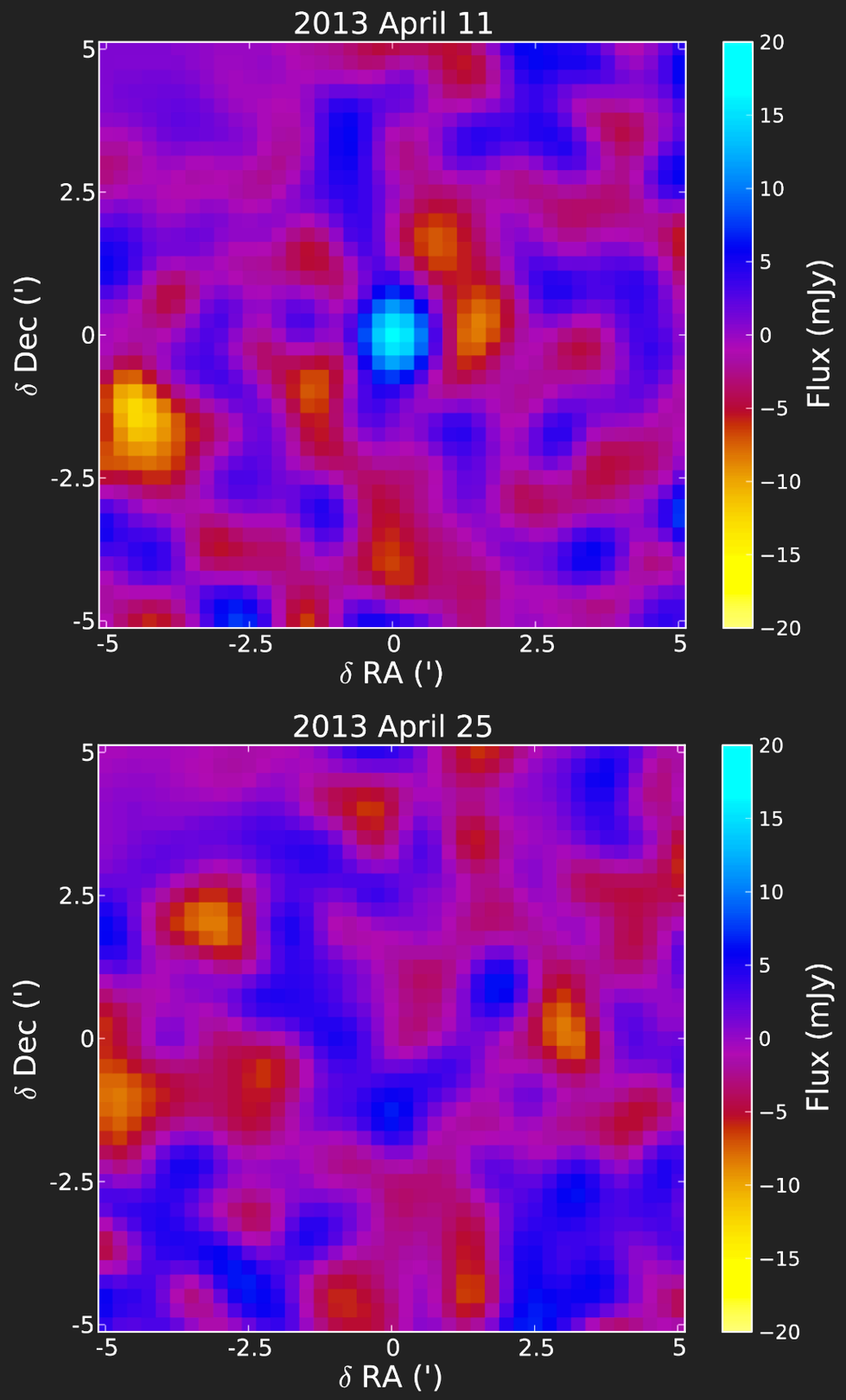
Sixteen short bursts of photons in the energy range 0.2–1.5 MeV have been observed between 1969 July and 1972 July using widely separated spacecraft. Burst durations ranged from less than 0.1 s to ~30 s, and time-integrated flux densities from $\sim 10^{-5}$ ergs cm^{-2} to $\sim 2 \times 10^{-4}$ ergs cm^{-2} in the energy range given. Significant time structure within bursts was observed. Directional information eliminates the Earth and Sun as sources.

HOW DO WE FIND THEM?

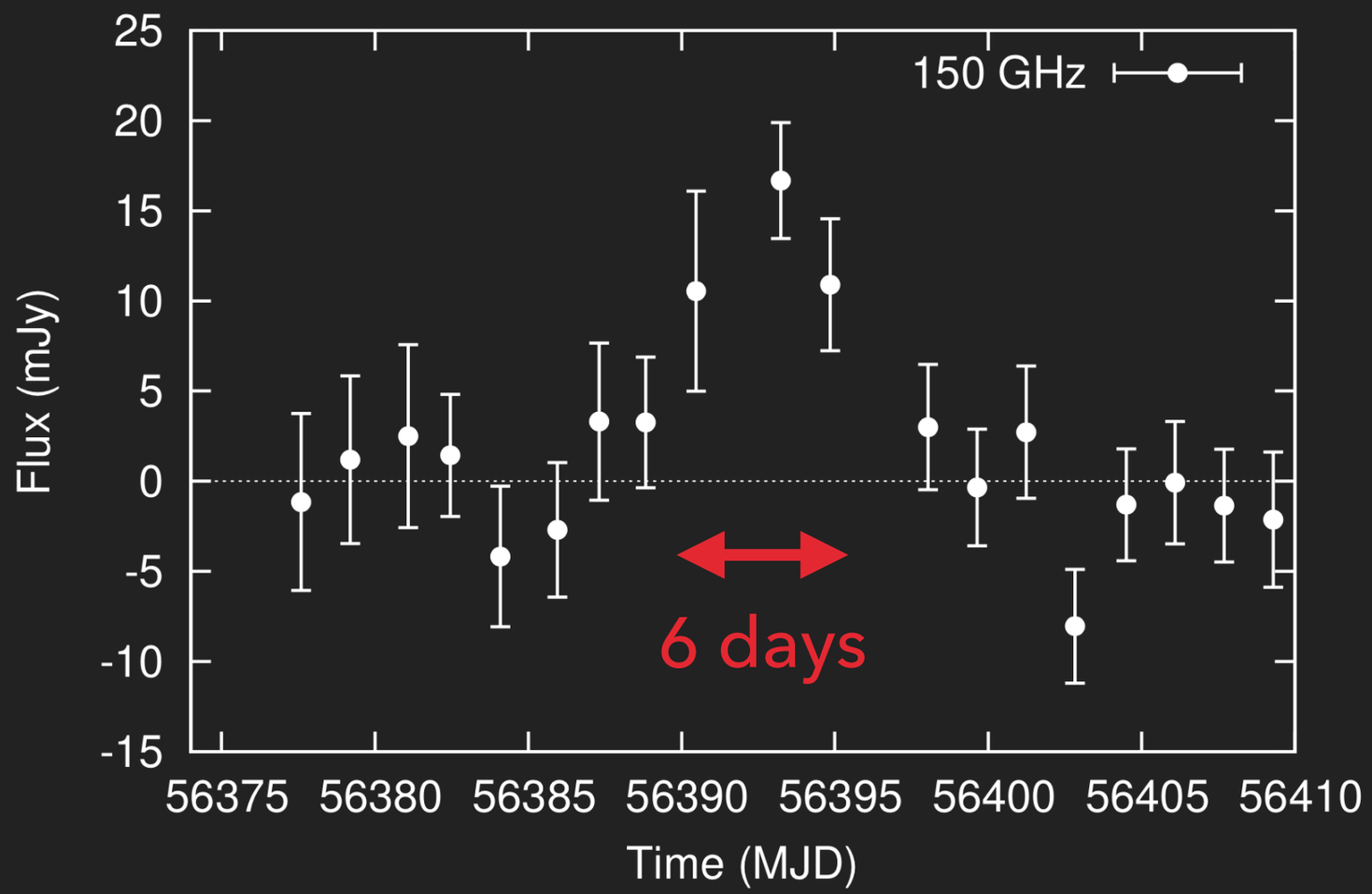
- Energy spectrum peaks at ~100 GHz
- Good angular resolution
- Wide survey area
- Obsessive observation of the same part of the sky

Pi of the Sky, GRB 080318B

SPTPOL CANDIDATE EVENT: APRIL 8–13, 2013



- Need real time follow-up!

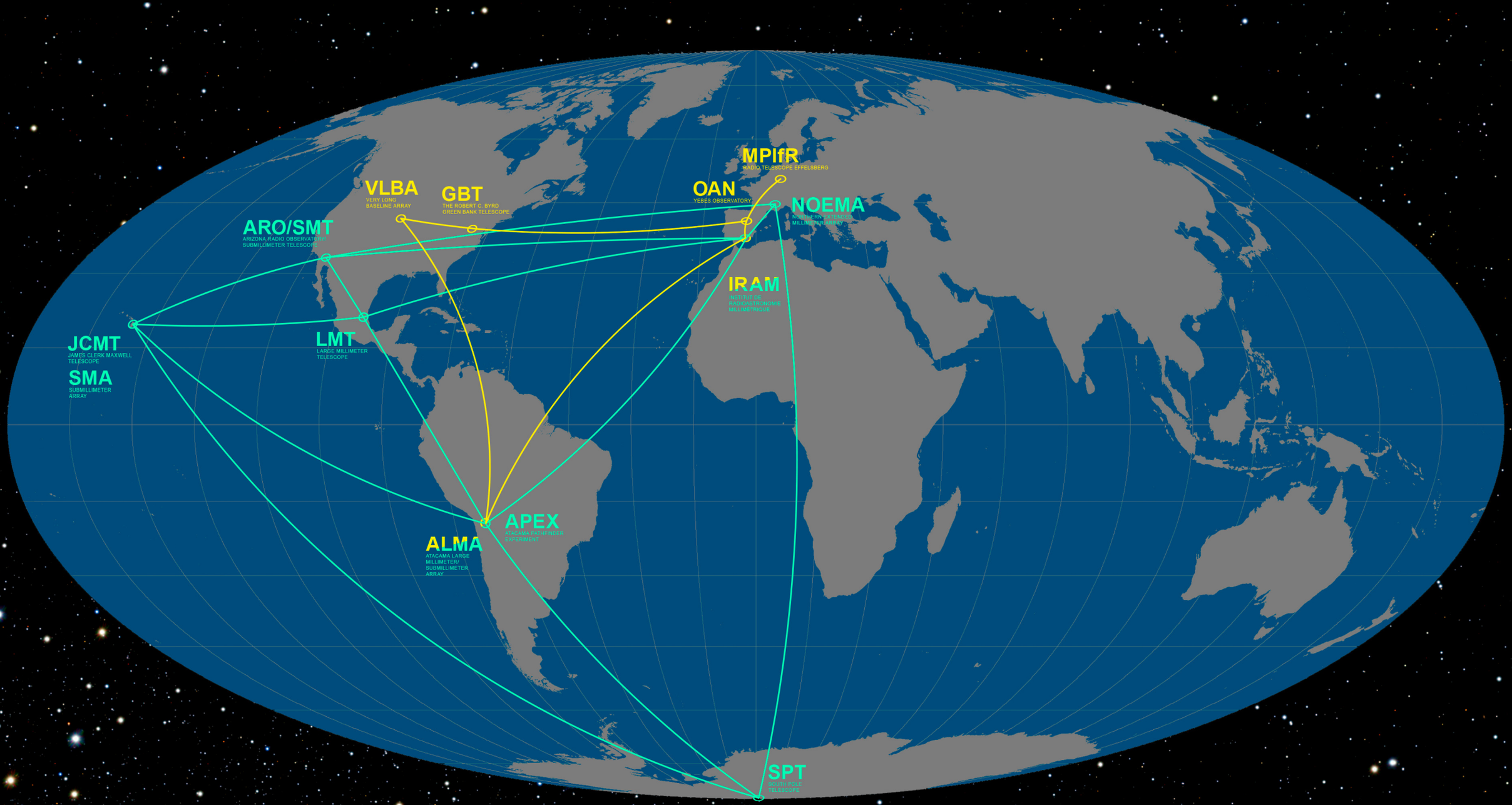


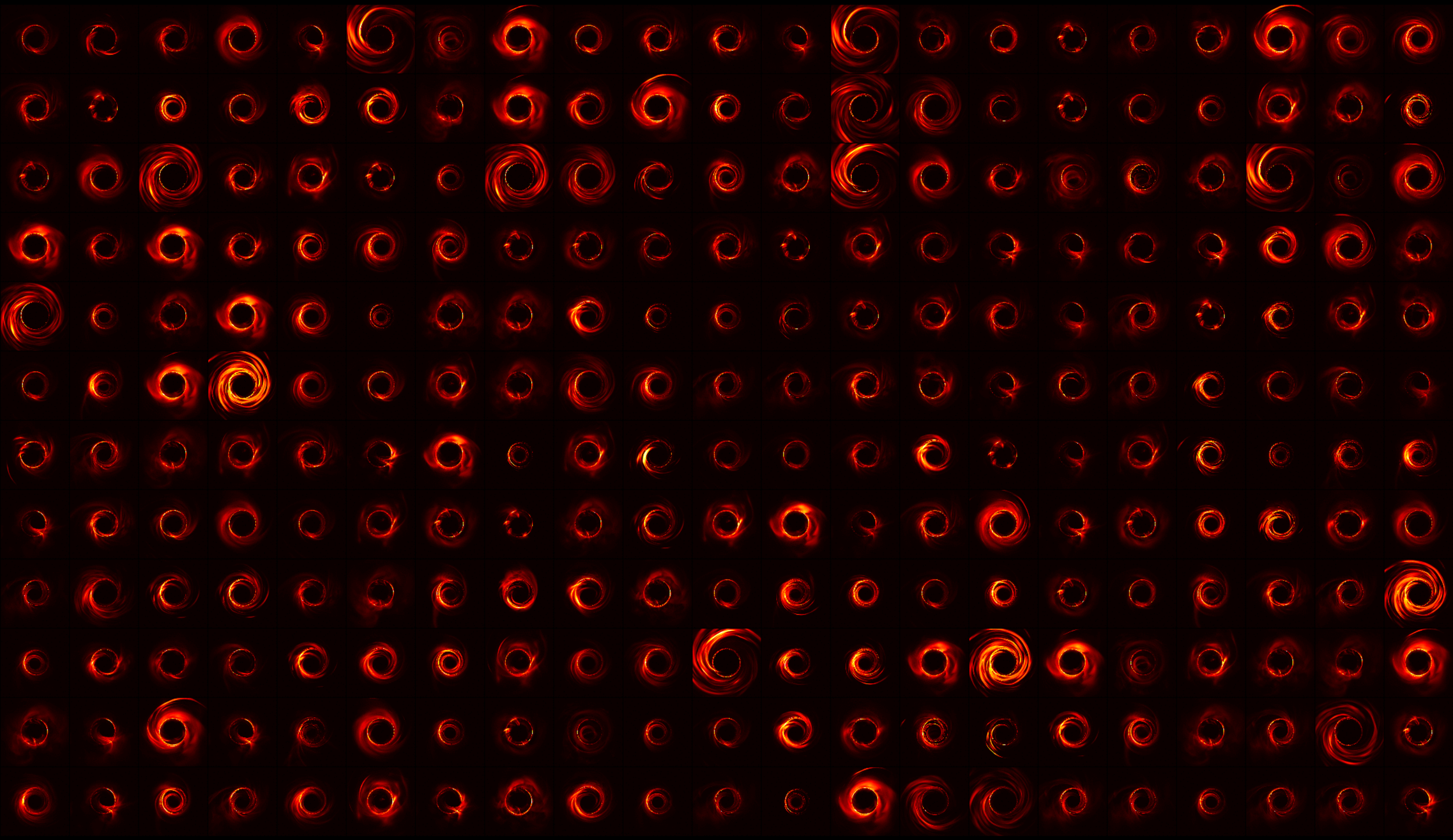
WHAT'S THE SMALLEST THING WE CAN SEE?

M87*

50 micro arc-seconds

Event Horizon Telescope





Credit: EHT Theory and Simulation Working Group

VERY LONG BASELINE INTERFEROMETRY

Black hole

Noise

Radio telescope

Hydrogen maser clock

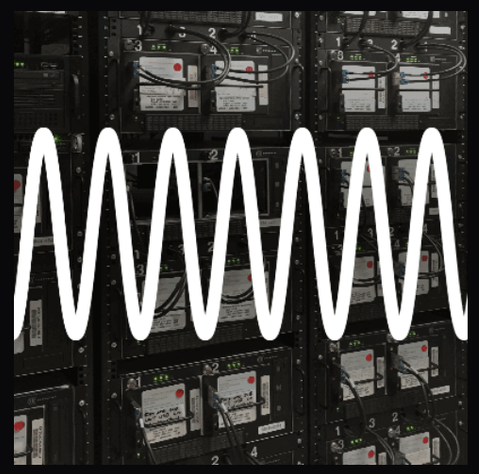
Correlator

Hard drive

Radio telescope

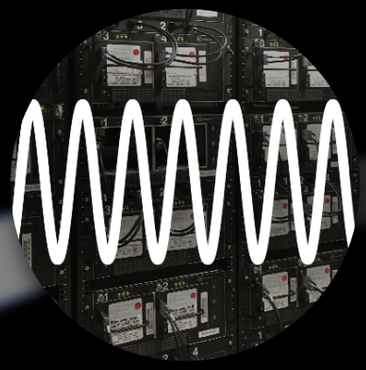
Hydrogen maser clock

Hard drive



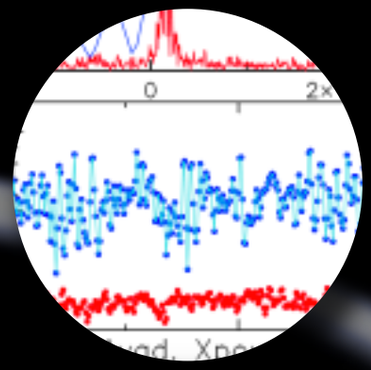
Credit: Rosie Johnson

Correlation
1/1,000



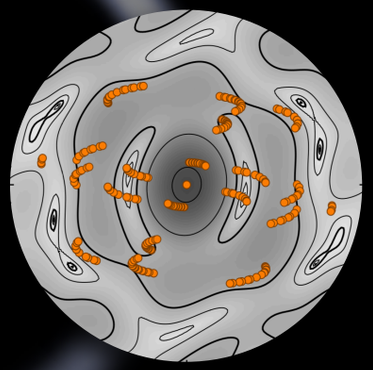
Jan 2018

Fringe Fitting
1/10,000



Jun 2018

Imaging
1/1,000



August 2018

Data Modules
5 petabytes

Nov 2017

EHT Array

Apr 2017

Announcement

April 2019

Credit: Dan Marrone (University of Arizona)

WHAT'S NEXT?

- Joint NSF and DOE funded project
- Large-aperture and small-aperture telescopes at the South Pole and Chile
- 500,000 detectors at 9 frequencies (20-300 GHz)
- Survey 40% of the sky
- Coming online in 2026!


The U.S. National Science Foundation
welcomes you to
Amundsen-Scott
South Pole Station
NSF
90°00′ South
established 1957

THANKS!